

Startup protocol for 10GBASE-T

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Outline

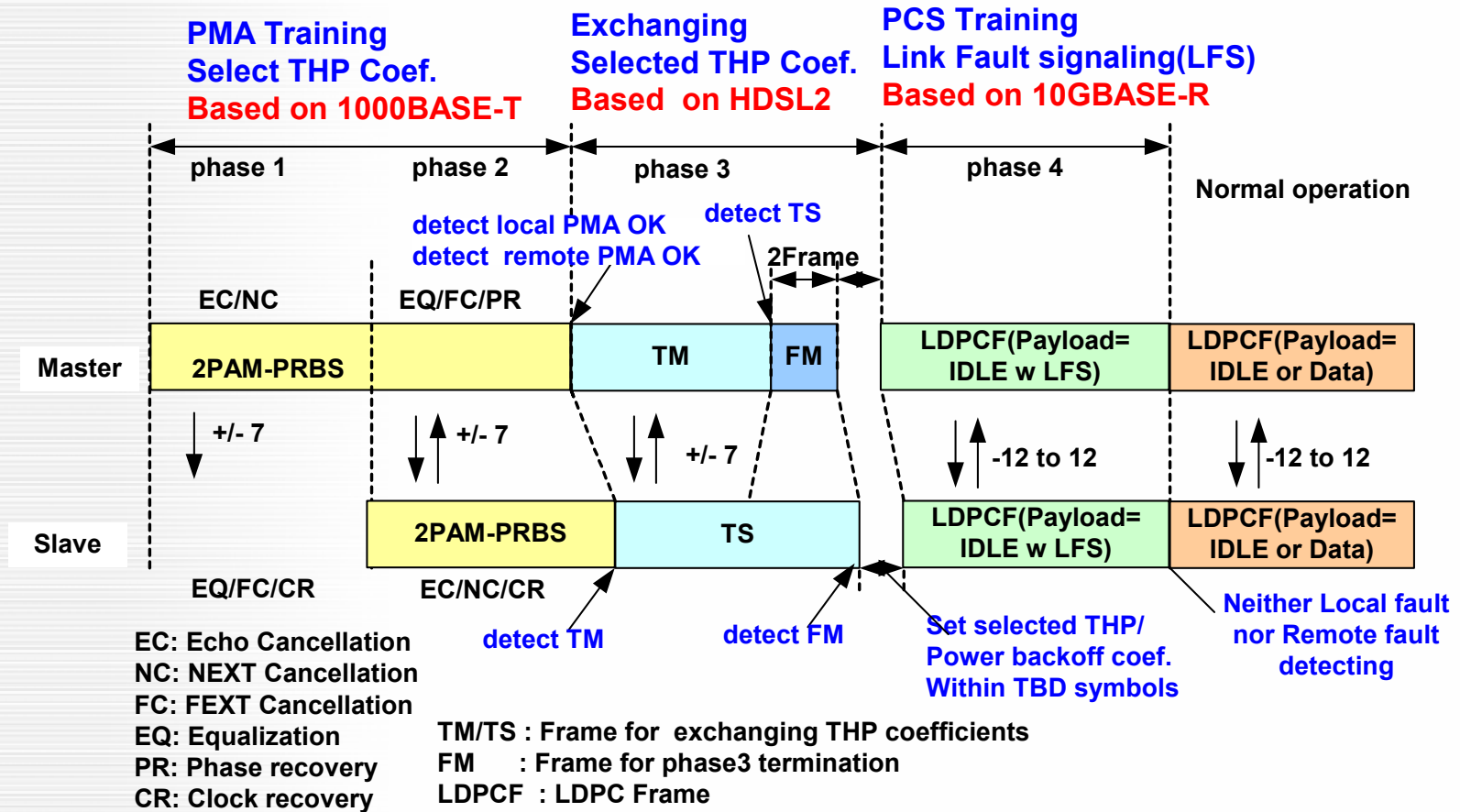
- Objectives
- Startup sequence
- State diagram
- PMA training signal
- THP/Power backoff coef. exchange frame
- Conclusion

Objectives

- Recover timing and adaptive filter coefficients
- Establish polarity correction, pair swap, pair deskew
- Establish LDPC block boundary
- Select THP coef. and power backoff coef.

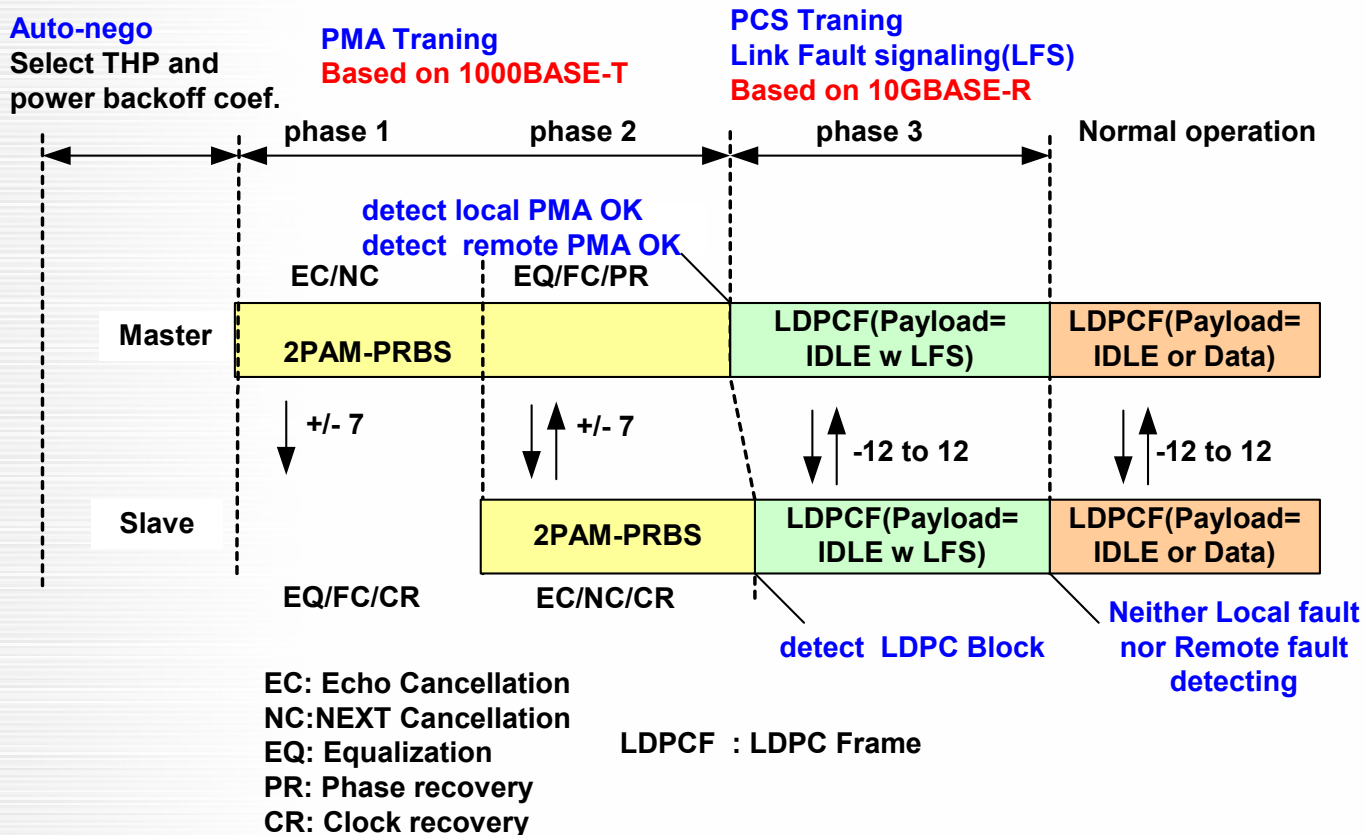
Start up sequence

Exchanging THP and power backoff coef at startup

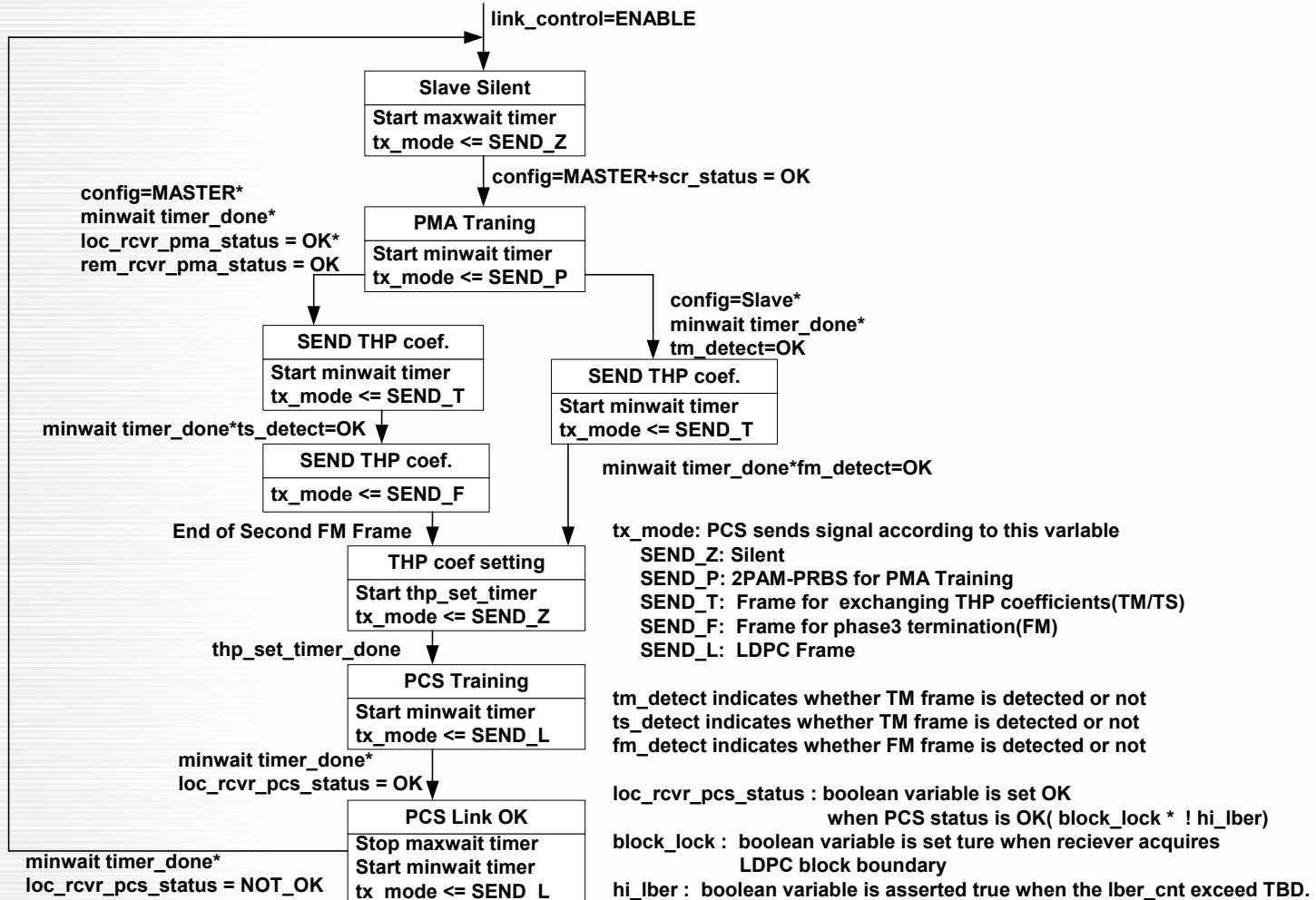


Startup sequence (Cont)

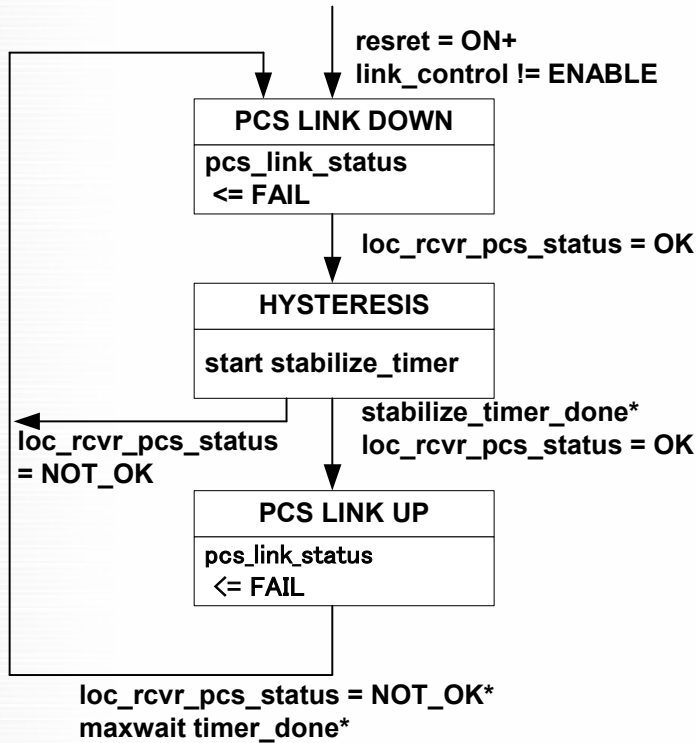
If THP and power backoff coef. is selected at AN, Coef exchange sequence can be eliminated.



PHY Control State Diagram



PCS Link Monitor State Diagram



The variable `pcs_link_status` and `link_control` are designated as `link_control_(10GigT)` and `link_status_(10GigT)`, respectively, by Auto-negotiation Arbitration state diagram (Fig28-16)

PMA Training signal

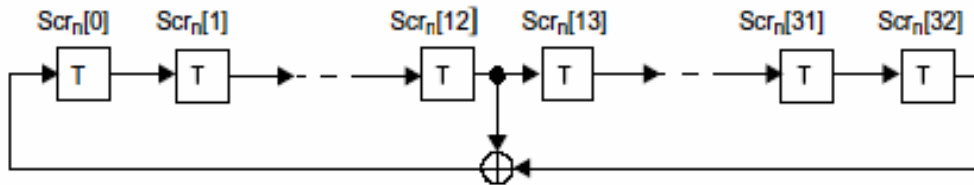
Objective:

Recover timing and adaptive filter coefficients

Establish polarity correction, pair swap, pair deskew

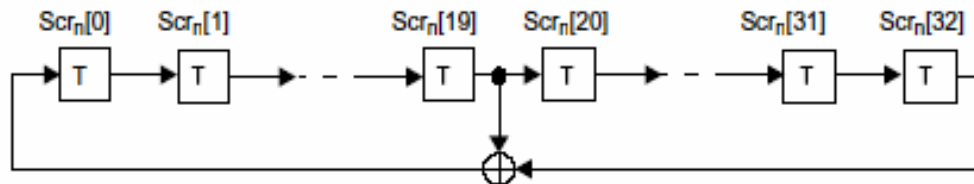
Side stream scrambler: (ref IEEE802.3 40.3.1.3.1)

Side-stream scrambler employed by the MASTER PHY



$$g_m(x) = 1 + x^{13} + x^{33}$$

Side-stream scrambler employed by the SLAVE PHY



$$g_s(x) = 1 + x^{20} + x^{33}$$

PMA Training signal (cont')

Generation of bits $Sy_n[3:0]$

$$Sy_n[0] = Scr_n[0]$$

$$Sy_n[1] = g(Sy_n[0]) = Scr_n[3] \wedge Scr_n[8]$$

$$Sy_n[2] = g(Sy_n[1]) = Scr_n[6] \wedge Scr_n[16]$$

$$Sy_n[3] = \begin{cases} g(Sy_n[2]) = Scr_n[9] \wedge Scr_n[14] \wedge Scr_n[19] \wedge Scr_n[24] & \text{if } (loc_rcvr_pma_status = NG) \\ g(Sy_n[2]) \wedge Sy_n[0] = Scr_n[9] \wedge Scr_n[14] \wedge Scr_n[19] \wedge Scr_n[24] \wedge Scr_n[0] & \text{else} \end{cases}$$

$$g(x) = x^3 + x^8$$

Generation of Transmit symbol vector

$$A = \begin{cases} 7 & \text{if } (Sy_n[0] = 0) \\ -7 & \text{else} \end{cases} \quad B = \begin{cases} 7 & \text{if } (Sy_n[1] = 0) \\ -7 & \text{else} \end{cases}$$

$$C = \begin{cases} 7 & \text{if } (Sy_n[2] = 0) \\ -7 & \text{else} \end{cases} \quad D = \begin{cases} 7 & \text{if } (Sy_n[3] = 0) \\ -7 & \text{else} \end{cases}$$

This PMA training signal can meet objectives of polarity correction, pair swap, pair deskew.

PMA Training signal (cont')

Polarity correction

$$Ry_n[x] \wedge Ry_{n-13}[x] \wedge Ry_{n-33}[x] = \begin{cases} 0 \text{ (polarity = OK)} \\ 1 \text{ (polarity = NG)} \end{cases} (x = 0,1,2,3)$$

$Ry_n[x]$: PAM2 demapping data of Lane x

Pair swap, deskew

$$Ry_n[x] \wedge Ry_{n-3}[x-1] \wedge Ry_{n-8}[x-1] = \begin{cases} 0 \text{ (skew = OK)} \\ 0/1 \text{ (skew = NG)} \end{cases} (x = 1,2)$$

if (remote side PMA status = NG)

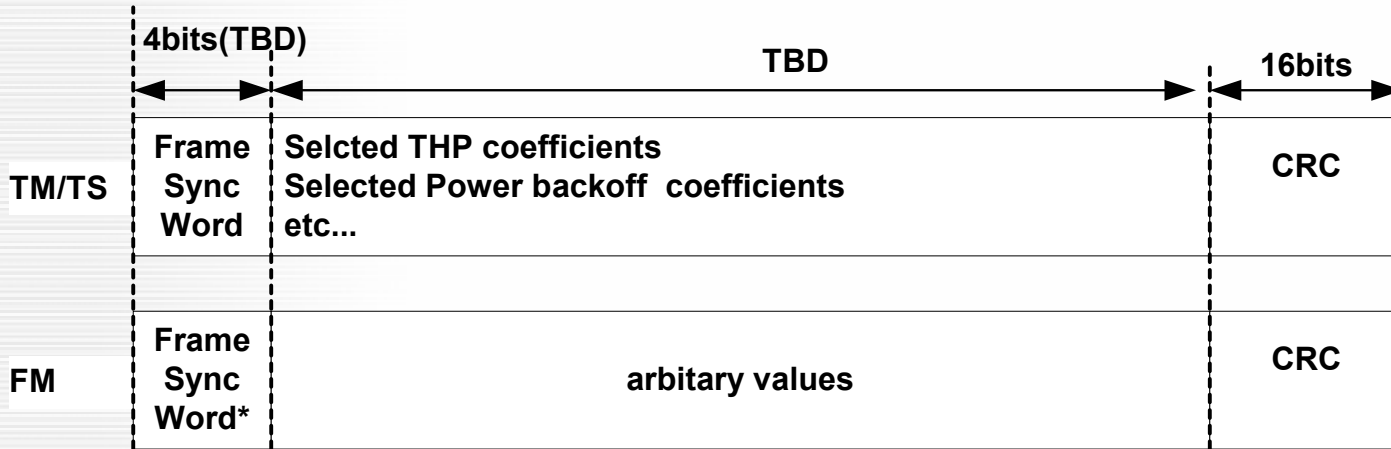
$$Ry_n[3] \wedge Ry_{n-3}[2] \wedge Ry_{n-8}[2] = \begin{cases} 0 \text{ (skew = OK)} \\ 0/1 \text{ (skew = NG)} \end{cases}$$

else

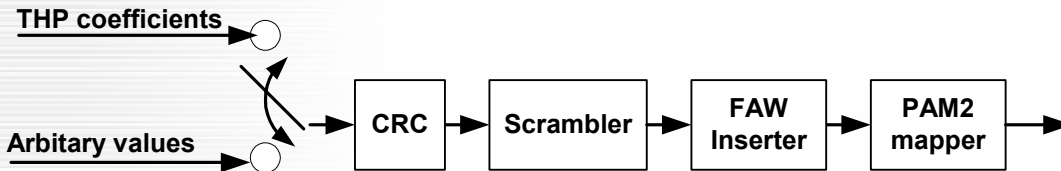
$$Ry_n[3] \wedge Ry_{n-3}[2] \wedge Ry_{n-8}[2] \wedge Ry_n[0] = \begin{cases} 0 \text{ (skew = OK)} \\ 0/1 \text{ (skew = NG)} \end{cases}$$

By using the relationship, PMA status of remote side receiver (rem_rcvr_pma_status) can be detected

Parameter exchanging Frame



The frame sync word of FM Frame shall be reversed in time



CRC generator polynomial : $g(x)=x^{16}+x^{12}+x^5+1$
Scrambler Polinomial : $g(x)=x^{23}+x^5+1$ (Master)
 $g(x)=x^{23}+x^{18}+1$ (Slave)

Ref. ITU-T G.991.2 "Single-pair high-speed digital subscriber line(SHDL)" Sec .7.2

PAM2 mapping

$$A = \begin{cases} 7 & \text{if } (TxTM < 4n \geq 0) \\ -7 & \text{else} \end{cases}$$

$$B = \begin{cases} 7 & \text{if } (TxTM < 4n + 1 \geq 0) \\ -7 & \text{else} \end{cases}$$

$$C = \begin{cases} 7 & \text{if } (TxTM < 4n + 2 \geq 0) \\ -7 & \text{else} \end{cases}$$

$$D = \begin{cases} 7 & \text{if } (TxTM < 4n + 3 \geq 0) \\ -7 & \text{else} \end{cases}$$

Conclusion

- **Startup sequence**

- 1) **Select predetermined or Programmable coefficients at startup**
- 2) **Select predetermined coefficients at auto-negotiation**

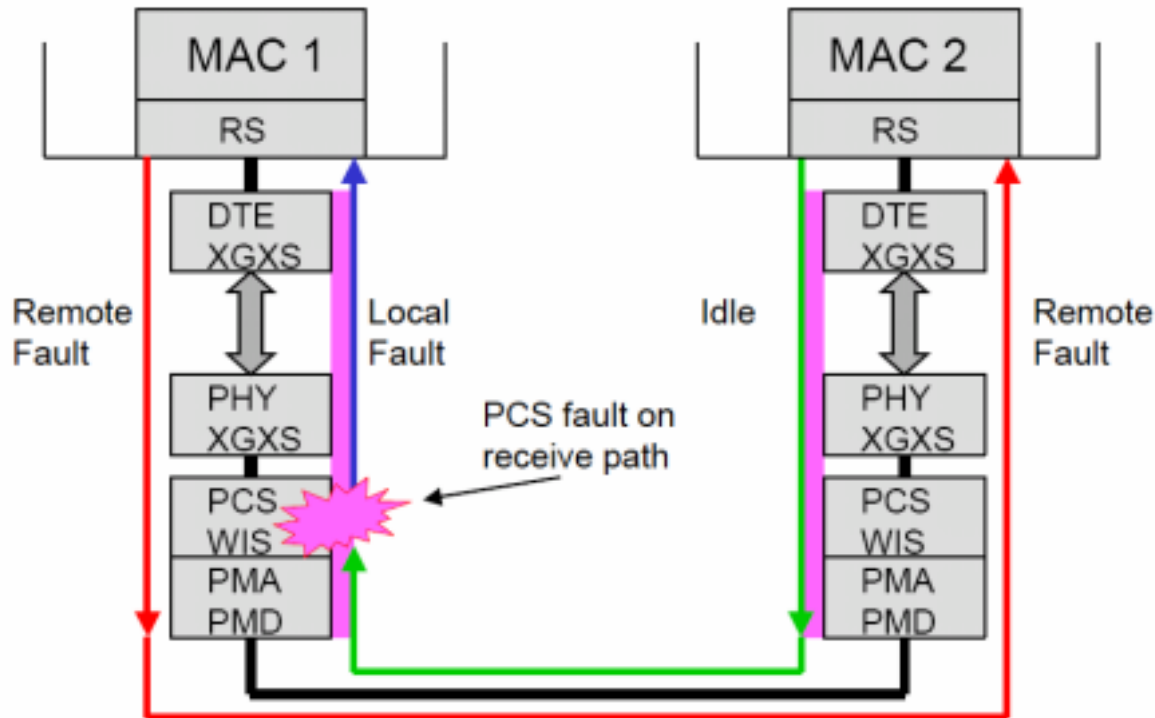
TF needs further investigation about THP/Power backoff coef choosing method

- **By using proposed PMA training signal, polarity correction, pair swap, pair deskew can be established**



Backup

10GBASE-R Link fault signaling



From http://www.ieee802.org/3/efm/public/nov01/turner_1_1101.pdf

- Intermediate link elements initiate Local Fault(LF) and forward status message
- RS layer initiates Remote Fault(RF) status in response to reception of LF
- Link status should be "UP(OK to send packet)" only when RS layer is detecting neither RF nor LF, that is, all sublayer's protocol is OK.